Physical Review E - Statistical Physics, Plasmas, Fluids, and Related Interdisciplinary Topics 2000 vol.61 N4 A, pages 3441-3449

Proton model of ferroelectrics with tunneling in the static fluctuation approximation

Nigmatullin R., Khamzin A., Ghassib H.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

The transverse Ising model is considered in the static fluctuation approximation. This hinges on the replacement of the local field operator with its mean value; only the quadratic fluctuations of the local field are retained. The model is applied to ferroelectrics of the order-disorder type, such as monoaxial crystalline threeglycinsulfate. Analytic expressions are derived for the spontaneous polarization, the specific heat, the pair correlation function, and the static susceptibility of this ferroelectric. Its main characteristics are then determined numerically as functions of the temperature. In particular, its critical behavior is obtained automatically for a specific value of some "control" parameter. It is predicted that, with respect to this parameter, the specific heat exhibits a logarithmic behavior to the right of the critical point; this is interpreted as a consequence of the long range and axial anisotropy of the dipole-dipole interaction. In passing, the behavior of the lattice Green function for the anisotropic dipole-dipole potential near the critical point is thoroughly examined.